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GROWING AND UTILIZING SORGHUMS FOR FORAGE

UNITED STATES DEPARTMENT OF AGRICULTURE

SORGHUMS are for the most part natives of Africa, and most of the varieties now grown in the United States originated on that continent.

It is estimated that in 1924 more than 5,000,000 acres of sorghum were grown for forage in the United States. Most of this acreage was located in the Southeastern States and in the sourthern half of the Great Plains.

The principal varieties of the sweet sorghums, considered from a forage standpoint, are the Black Amber, Orange, Sumac, Honey, Atlas, and Gooseneck. The grain sorghums most valuable for forage are Hegari and the Blackhull, Red, Pink, and Dwarf kafirs.

There is little difference in the yield of sorghum planted in rows 40 inches apart and that sown in close drills, but the cultivated rows are most dependable in seasons of low rainfall.

Sorghum which has matured, or at least headed, not only makes a better quality of fodder but is less dangerous to pasture.

Sorghum varieties hybridize freely, and lack of uniformity can be prevented only by constant attention to the purity of the seed used. Each farmer should select in the field the seed intended for his own plantings.

Sorghum is most useful as a hay crop in the Southern States because of its certainty of producing a crop and on account of the failure of ordinary hay crops, such as timothy and alfalfa, in that section.

Both the sweet sorghums and the grain sorghums are excellent silage crops. Stockmen in the Great Plains area can avoid the loss of thousands of cattle by feeding sorghum silage which has been stored at a small expense in pit silos.

The most serious disadvantage in the use of sorghums as a pasture or soiling crop is the danger of prussic-acid poisoning.

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GROWING AND UTILIZING SORGHUMS FOR FORAGE.

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CONTENTS.

IMPORTANCE OF THE SORGHUM CROP.

THE SORGHUMS are for the most part native of tropical Africa. Over 1,200 separate lots of sorghum seed have been received from foreign countries, but the most important single shipment is probably that of 16 varieties from Natal, South Africa, in 1857. At first, most attention was devoted to the growing of sorghums as a source of sirup and sugar. The settlement of the prairie lands in the semiarid West created a demand for drought-resistant forage crops, and Kansas alone now harvests a larger acreage of sweet sorghums for forage than the total acreage grown in the United States for sirup. It is estimated that at least 5,000,000 acres of sorghum were used for fodder and silage in the United States in 1924.

This bulletin treats of the culture and utilization for forage both of the sweet sorghums and the grain sorghums. Because of the adaptation of these crops to climatic conditions in the southern Great Plains, it will be most useful in that section, but the information will be found valuable wherever sorghum is grown for forage.

AREAS SUITED TO SORGHUM PRODUCTION.

The principal sorghum-producing areas are illustrated on the map shown as figure 1. In the southern Great Plains sorghum is the most dependable crop. In western Texas, Oklahoma, and Kansas and in eastern New Mexico and Colorado it should form the basis of agriculture in connection with live-stock production. In this region sorghum varieties properly chosen can be depended on both for grain and forage. Except at high elevations, sorghum can, however, be grown as a secondary forage crop in all parts of the United States up to within about 200 miles of the northern boundary.

RELATION OF SORGHUM TO CLIMATE.

The sorghums do best in the southern half of the United States, where the temperatures are uniformly high during the growing season. The most favorable temperature for their growth is perhaps about 90° F., and they grow very little when it is below 60° F.[1] These temperature requirements prevent sorghums from being grown at very high altitudes. The limits of successful production are reached at altitudes of 5,000 to 6,000 feet in Wyoming and Colorado, and at 7,000 feet in Arizona and New Mexico.

Sorghum is not so exacting in its moisture requirements as in its temperature relations. Despite the fact that the largest sorghum area in the United States is in a region of low and uncertain rainfall,

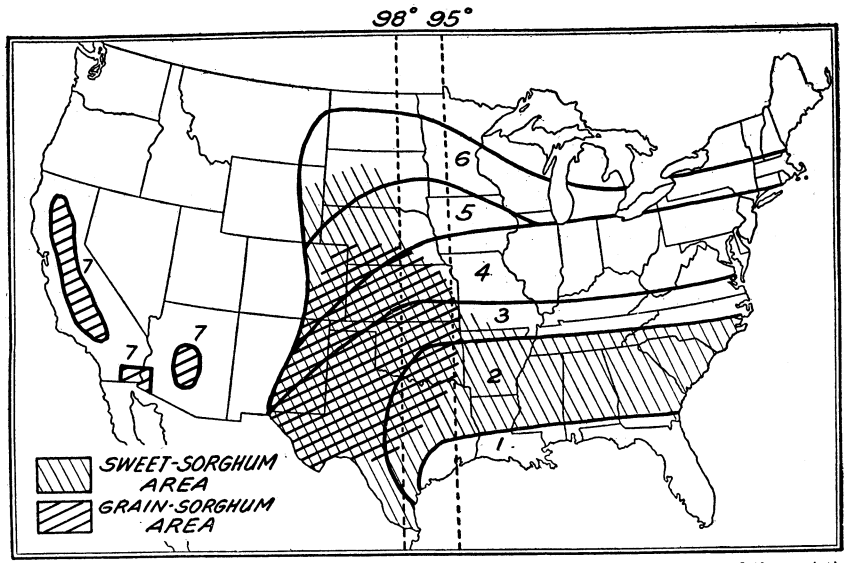

FIG. 1.—Outline map of the United States, showing the principal forage-sorghum areas and the varieties recommended for each. The principal grain-sorghum regions, besides the southern Great Plains, include the Salt River and Yuma Valleys in Arizona and the Imperial, San Joaquin, and Sacramento Valleys in California.

the crop thrives where the rainfall is heavy. Sorghum is grown extensively in the semiarid plains, not because a low rainfall is necessary, but because sorghum is more productive than other crops under such conditions.

VALUE OF SORGHUM UNDER DROUGHTY CONDITIONS.

The sorghums are of most value in regions of uncertain rainfall because they remain practically dormant during a period of drought and resume growth as soon as there is sufficient rain to wet the soil. In addition, the sorghum plant has almost twice as many secondary roots or feeders per unit of primary root as corn and is thus more

[1] Vinall, H. N., and Reed, H. R. The effect of temperature and other meteorological factors on the growth of sorghums. *In* Jour. Agr. Research, v. 13, no. 2, p. 133–148, pl. 11–12. 1918. Literature cited, p. 147

efficient in absorbing moisture from the soil. It also has been found that the leaf system or transpiration surface is on the average only about half as great as that of corn. This combination of an efficient absorbing system with a reduced leaf area no doubt accounts in a large degree for the greater ability of the sorghums to withstand drought.[2]

Carefully conducted experiments with corn, milo, and kafir covering a period of six years at Garden City, Kans., and at Amarillo and Dalhart, Tex., show that corn was grown at a loss both at Garden City and Amarillo and returned only a small profit at Dalhart, even when the stover or fodder was assigned a value of $4 per ton. Milo returned a profit at all three stations, varying from $2.07 per acre at Garden City to $11.14 at Dalhart. Kafir did equally well, returning an acre profit of $3.78 at Garden City, $8.21 at Amarillo, and $12.07 at Dalhart. The larger portion of this value in each case was derived from the forage, as in many instances no grain was produced.

The sorghums have fully established their reliability under droughty conditions in the southern Great Plains both for forage and grain. The farmer who continues to grow corn and wheat as his main crops in this sorghum belt is deliberately inviting disaster.

SOIL RELATIONS.

Sorghum thrives on a variety of soils. Deep, fertile sandy loams are best, but fair crops can be produced on heavy clays if they are well drained. Land too poor and thin to grow corn or wheat seldom produces a profitable crop of sorghum. It is not a wise practice to grow sorghum on poor or worn-out lands. A legume, like cowpeas or clover, should be substituted in the crop system and the productive power of the soil restored by applications of commercial fertilizers or barnyard manure.

Sorghum is more tolerant of alkali in the soil than most crops. It is claimed that good crops of fodder can be obtained on soils where the amount of alkali is between 0.4 and 0.6 per cent and that fair crops may be expected on soils with 0.6 to 0.8 per cent of white alkali, but satisfactory grain yields are not often obtained.

EFFECT ON THE LAND.

Sorghum has the reputation of being "hard on the land." This expression is commonly applied by farmers to crops which seem to have an adverse effect on the yields of succeeding crops. The belief that corn, oats, wheat, and other crops yield less on fields that have produced a crop of sorghum the previous year than on fields where the preceding crop was corn or small grain is supported by rotation experiments in Alabama, Arkansas, Kansas, and Nebraska. In these

[2] Miller, E. C. Comparative study of the root systems and leaf areas of corn and the sorghums. *In* Jour. Agr. Research, v. 6, no. 9, p. 311–332, pl. 38–44. 1916.

four States the average grain yield of the above crops after corn was 24.5 bushels and after sorghum 20.7 bushels per acre. This difference of approximately 15 per cent in the yield of the crop following sorghum is sometimes, if not always, balanced by the large yield of sorghum. At the Kansas Agricultural Experiment Station the 3-year average yield of corn after sorgo was 40.8 bushels, corn after kafir 44 bushels, and corn after corn 54.6 bushels per acre. The acre value of the crops in the 2-year rotation, however, was in the first case $31.15, in the second $34.46, and in the third $28.14.

Several factors contribute to the low yield of crops following sorghum. The most important one in the dry regions is probably the rather complete exhaustion of soil moisture by the sorghum. Another is the bad physical condition of the soil resulting from the lack of humus and deflocculation due to decay of the sorghum stubble.[5] Where sorghum has been grown in cultivated rows little vegetable matter is left on the surface of the soil to decay and form humus, and the roots hold on to the soil so tenaciously that the stubble is difficult to break up in the fall and may give some trouble the following spring.

Because of these effects on the soil, fall-sown grain does not usually succeed on a sorghum field. It is best, therefore, to follow sorghum with a spring-sown crop or summer fallow.

USE OF FERTILIZERS

In the Great Plains, where the larger part of the sorghum acreage is located, most of the plantings are made on comparatively new land, and but little fertilizer is used. The limiting factor in all this region is the rainfall and not soil fertility.

In the Southeastern States any complete fertilizer which is known to be beneficial to corn under local conditions may be expected to prove profitable when applied to sorghum. Where forage is the chief consideration it is desirable to have the nitrogen content of the fertilizer rather high. In the cotton belt it has been a common practice to apply 200 to 300 pounds of cottonseed meal per acre to land that is to be planted to sorghum.

CLASSIFICATION OF SORGHUM VARIETIES.

The sorghums may be divided into four broad groups: (1) Sorgos, or sweet sorghums, (2) grain sorghums, (3) grass sorghums, and (4) broom corns. The first group includes those varieties with sweet, juicy stems and seeds of little value for feeding as grain on account of the high tannin [6] content. The second group includes varieties with pithy or only slightly juicy stems, but producing grain comparatively free from tannin and therefore of high feeding value. The third

[5] Breazeale, J. F. The injurious after-effects of sorghum. *In* Jour. Amer. Soc. Agron., vol. 16, pp 689–700. 1924.

[6] Recent investigations make it appear doubtful that this bitter principle in the seed of sweet sorghums is tannin. It resembles tannin, however, in being both bitter and astringent.

group are leafy, fine-stemmed sorghums, like Sudan grass, useful principally as hay plants. In the fourth group, also the plants have dry, pithy stems, but are characterized chiefly by their long, loose panicles, or heads, which are utilized in the manufacture of brooms. Only the first two groups will be considered in this publication.

The sweet sorghums, often called "cane" by farmers, are used only for forage and sirup. In this publication the name sorgo is used to denote the sweet sorghums rather than the word "cane," which properly belongs to the sugar canes, an entirely different group of plants, represented by the botanical genus Saccharum. The use of the term "cane" for the sweet sorghums leads to confusion, especially in regions where sugar cane is commonly grown.

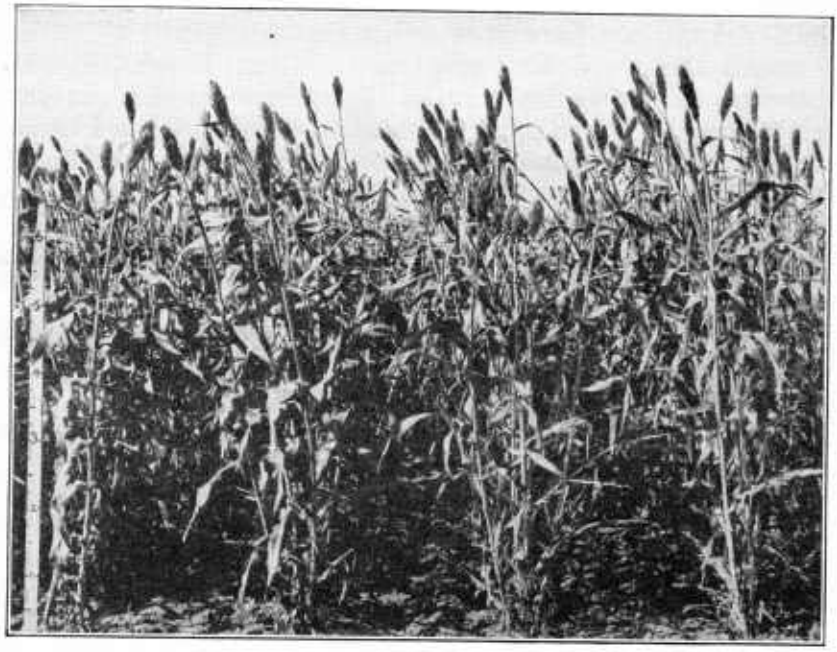

FIG. 2.—A field of Orange sorgo at Hays, Kans. This is one of the best varieties for silage in eastern Kansas.

An accurate estimate of the number of sorgo varieties is impossible. The most important ones are the Minnesota or Black Amber, Dakota Amber, Orange (fig. 2), Sumac, Atlas, Honey (sometimes called "Japanese cane"), and Gooseneck (known also as "Texas Seeded Ribbon cane"). The following varieties are less important or at least less widely grown: Red Amber, Planter, Sourless (also called "White Orange"), Sapling, Colman, Denton, Red X, Collier, Folger (or Folger's Early), McLean White African, and Dwarf Ashburn.

Grain sorghums are of most importance in the southern Great Plains and the irrigated portions of New Mexico, Arizona, and California (see fig. 1). In some grain-sorghum groups, kafir for example, more than 40 per cent of the total acreage is harvested for fodder. In exceptional years, when drought or early frosts prevent its development into a good grain crop, the amount of kafir utilized as forage has been estimated at more than 80 percent of the acreage in certain States. The percentage of milo and feterita harvested as fodder is always much less than that of kafir, because these crops, having drier stems and fewer leaves, are less palatable. They can, however, be used for silage if occasion demands and are frequently fed as fodder.

The varieties of grain sorghum most valuable for forage purposes are Hegari and the Blackhull, Dwarf, Sunrise, Pink, and Red kafirs. Additional varieties sometimes grown for forage include Schrock (Sagrain), Darso and Grohoma, Ajax, Chiltex, Bishop (Algeria), Cheyenne, Reed, and Hydro kafirs. Other varieties which in some regions are valued quite highly as grain crops but are of minor importance from a forage standpoint are the following: Standard, Dwarf, and White milo and feterita. Still other varieties of less value are the Shallu, Kaoliang, and Freed sorghum.

SORGHUM VARIETIES RECOMMENDED FOR DIFFERENT AREAS.

It is fully as important to minimize the effect of adverse climatic conditions by a wise choice of crops as it is to create more favorable conditions by means of irrigation or improved methods of culture. In no part of the United States is the truth of this statement more often confirmed than in the semiarid portion of the Great Plains, where the rainfall is so undependable. The sweet sorghums introduced from South Africa in 1857 and the kafirs and milos introduced more than 20 years later are being recognized as the crop basis of a permanent system of agriculture. Within these groups are many varieties differing in their abilities to endure droughts or to respond generously to abundant rains. An intelligent selection of varieties is the best insurance against failure, and the most reliable varieties for each part of the sorghum area are indicated in the following paragraphs, which refer to the map on page 4.

East of the 98th meridian and north of the lined area shown on the map (fig. 1), timothy and clover are more highly prized than the sorghums for hay, and corn can be depended upon for grain, fodder, and silage. Outside of the regions numbered and described below, sorghum is not well adapted and is of little importance.

Region 1.—For forage: Japanese sugar cane and Napier grass should be grown in preference to the sorghums, because they are more productive.

Region 2.—For forage: Sumac, Orange, Honey, and Gooseneck sorgos. For grain and forage: Corn and oats are preferable to the sorghums except in the section shown by cross-hatching in figure 1; there, Blackhull kafir and Dwarf hegari are more dependable than corn except on the river bottoms.

Region 3.—For forage: Sumac and Orange sorgos. For grain and forage: East of the 95th meridian, corn and the small grains; between the 95th and 98th meridians, Blackhull kafir; west of the 98th meridian, Dwarf kafir, Sunrise kafir, and Dwarf milo, with a small acreage of feterita as insurance against drought.

Region 4.—For forage: West of the 98th meridian, Early Sumac sorgo; east of the 98th meridian, Orange and Atlas sorgos. For grain and forage: East of the lined area (fig. 1), corn and the small grains; that portion of the lined area east of the 98th meridian, Blackhull and Pink kafirs on the uplands, corn on the river bottoms; west of the 98th meridian, Dwarf kafir, Pink kafir, Dwarf milo, and feterita.

Region 5.—For forage: Dakota Amber and Minnesota Amber sorgos. For grain and forage: In all except the lined portion (fig. 1), corn and the small grains; in the lined part, corn, feterita, Freed sorghum, White milo, and Dwarf milo.

Region 6.—For forage: West of 98th meridian, Minnesota Amber and Dakota Amber sorgos. For grain and forage: Early varieties of corn and the small grains.

Region 7.—For forage: Honey, Gooseneck, and Sumac sorgos. For grain and forage: Dwarf milo and Dwarf hegari.

The varieties named for the various regions shown on the map (fig. 1) are recommended on the basis of the normal seeding date. When it becomes necessary for any reason to seed after the most favorable date, then it is often desirable to use an earlier maturing variety. For late seeding in region 2 the Orange is preferable to the Sumac, Honey, or Gooseneck; in region 3 the Early Sumac and Orange should be used in place of the Sumac; and in regions 4 and 5 the Freed sorghum and Minnesota Amber sorgo often make a better crop than the Atlas or Orange when planted late in the season. Freed sorghum is particularly suited to such uses and can be used in this way over the entire grain-sorghum area to better advantage than as a regular-season crop.

The sweet sorghums produce a higher yield of forage than the grain sorghums, and the earlier varieties also produce good yields of seed. This seed is of low value as grain, however, and is used mostly for seed purposes. Many farmers in the Great Plains prefer a sorghum which can be utilized as a grain crop in seasons of favorable rainfall and yet be utilized for forage if it does not promise a profitable grain yield. Grain sorghums are therefore included in the varieties recommended for the different regions. For forage alone the sorgos are preferable to the grain sorghums, but in many instances the forage is a secondary consideration to the grain, which can be fed on the farm or marketed for cash.

DATE AND METHOD OF SEEDING SORGHUMS.

In the southern part of the sorghum region, where there is danger of injury to the grain by the sorghum midge, the crop should be

seeded as early as climatic and soil conditions permit—usually early in March. If forage only is desired, however, seeding may be done at any favorable time up to July 15. Farther north the seeding should be delayed until May. In the latitude of Oklahoma and Kansas May 15 to June 1, on the average, is the best period for seeding. A safe rule in all localities except where the sorghum midge is troublesome is to seed about two weeks after corn-planting time. All sorghums are sensitive to cold soils and grow slowly until the soil becomes thoroughly warm. No advantage is gained, therefore, by seeding in a cold soil.

Perhaps 85 per cent of the sorghum acreage is planted in rows sufficiently far apart to permit cultivation with an ordinary corn cultivator. When the sorgos are grown exclusively for forage purposes other than silage many farmers prefer to sow them broadcast or drill them with a grain drill (fig. 3). This is a good practice, except in regions subject to drought or when in the growing of sorghums grain production is a feature to be considered. In such cases planting in rows is preferable. In general, there is very little difference in yield between the fields that are sown or drilled and those planted in widely spaced rows. The average yield of Red Amber and Sumac sorgos in tons per acre for a series of years at the Department field stations on the Great Plains is shown in Table I.

TABLE I.—*Average yields of leading varieties of sorgo at field stations of the United States Department of Agriculture on the Great Plains in recent years.*

Series of years.	Location.	Yield per acre (tons).	
		Rows.	Drilled.
1914 to 1918	Hays, Kans.[a]	3.15	3.82
1914 to 1917	Amarillo, Tex.	4.51	3.36
1914 to 1917	Chillicothe, Tex.[b]	4.93	4.50
Average		4.30	3.89

[a] All experiments at Hays, Kans., were conducted under a cooperative agreement with the Kansas Agricultural Experiment Station.
[b] All experiments at Chillicothe, Tex., were conducted under a cooperative agreement with the Texas Agricultural Experiment Station.

For planting in rows two general methods are followed—surface planting and listing, or planting in furrows. The first method is best suited to regions of moderate rainfall and the latter to dry sections.

Usually in surface planting sorghums the ground must be prepared by plowing and harrowing, after the practice followed in preparing ground for the seeding of a small grain crop (fig. 4). If, however, the soil is left clean and mellow by the preceding crop, it may be possible to prepare it by disking.

The ordinary corn planter, if provided with sorghum plates, will plant the seed satisfactorily. In order to distribute the seed evenly and prevent the plates from stopping up, the holes should be from three-sixteenths to one-fourth of an inch in diameter and reamed

out on the lower side. The number of holes in the plate can be varied from 12 to 24 in order to give the desired stand; or the number of seeds dropped may be regulated by changing the speed with which the plate revolves (fig. 5). Very little sorghum is checkrowed, as it has been found better to distribute the seed evenly in the row rather than drop it in hills.

When using a lister, sorghum may be successfully planted on grain stubble without much, if any, previous preparation. Ordinarily, however, it pays at least to disk in the spring before listing. Experiments at Hays, Kans., have shown that it is profitable to fall list land,

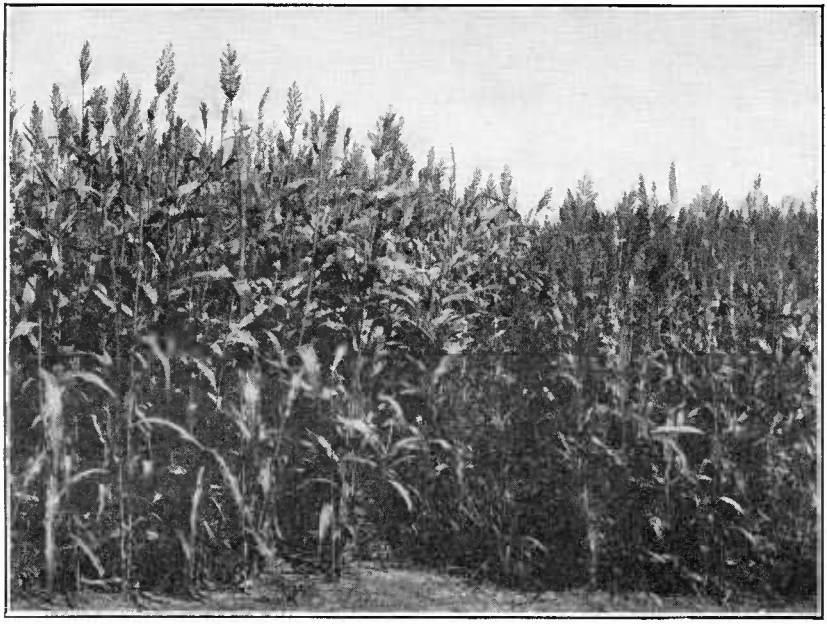

FIG. 3.—Sorgo drilled for hay. The plat on the left was sown at the rate of 15 pounds; that on the right, at 75 pounds to the acre.

level the ridges when weeds start in early spring, and then list again at planting time.[7] Fall listing should be done at right angles to the prevailing winter and spring winds in order to catch snow and prevent the soil from drifting. The illustration on the title-page shows a field of sorgo in shock in December, part of the field having been blank listed in preparation for the next season's crop.

Plates similar to those used in the surface planter are required for the lister. Sorghum planted with a lister usually starts growth more slowly in the spring, because the soil does not warm up so quickly at the bottom of the furrow. The roots are deeper in the soil, however, and a light rainfall, by collecting at the bottom of the furrow, becomes directly available to the small plants. Listed sorghum,

[7] Cunningham, C. C., and Kenney, Ralph. Growing sorghum in Kansas. Kans. Agr. Exp. Sta. Bul. 218, pp. 33–35. 1917.

though making a poor appearance in the early part of the season, is often more productive in the end than surface-planted sorghum.

Another advantage of the listed sorghum lies in the greater ease of keeping the weeds out of the row. The lister throws most of the weed seed out of the furrow, and by proper cultivation in the spring the weeds between the rows can be effectually destroyed in two cultivations. In surface-planted fields it is very difficult to remove the weeds in the rows without injuring the young sorghum plants, and four cultivations are often required to keep the crop clean. The western farmer who handles a large acreage is anxious to reduce the

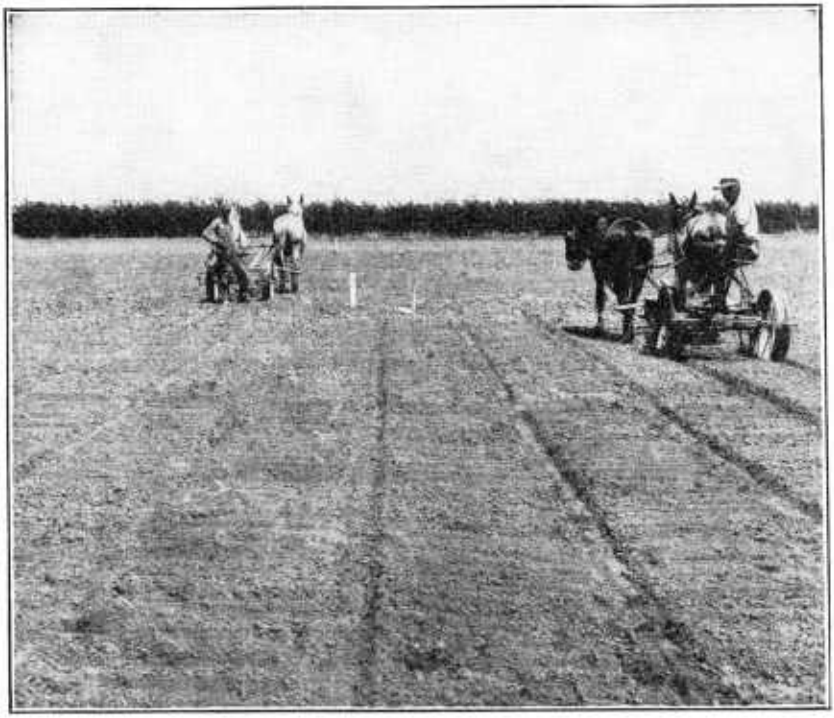

FIG. 4.—A field properly prepared for surface planting the sorghums.

labor required, and this fact has induced many to use the lister in preference to the corn planter (fig. 6).

An attachment to an ordinary corn planter which has been found especially useful in planting sorghums is the furrow opener. Two disks set just in front of the planter shoe open a shallow furrow, allowing the seed to be dropped in moist soil (fig. 7). This method of planting combines some of the advantages of listing by placing the seeds where they receive the full benefit of slight rains and in addition profit by the early warming of the soil in the spring. The prompt germination of the seed and the vigorous early growth of the plants are obtained

by this method, which is gaining in favor with farmers in the eastern part of the district, where the lister has been so generally used.

The preparation of land for the seeding of sorghum broadcast or with a grain drill is practically the same as for surface planting in rows. The land should be harrowed thoroughly after plowing. If the plowing has been done early in the spring it is best to disk the land before seeding, to destroy the weeds which have started. This is highly important, because if the weeds are not destroyed they develop with the crop of sorghum and not only interfere with its growth but lower the quality of the hay obtained. Most farmers plow the land just before seeding in order to avoid this extra working of the soil.

The great advantages in drilled or broadcasted seedings over cultivated-row plantings lie in the fact that no cultivation is needed after seeding and that the hay produced is of finer quality; that is, finer stemmed. The greatest drawback to such seedings is the failure of

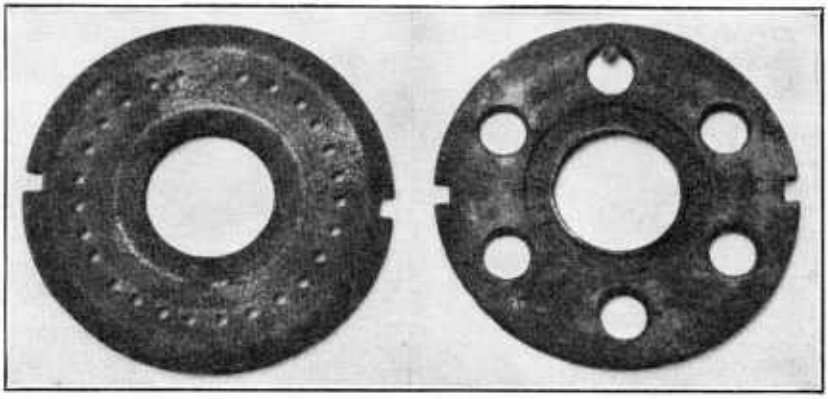

FIG. 5.—Plates used for planting sorghum and corn. On the left, a plate designed for planting kafir; on the right, one intended for dent corn

the sorghum to mature in seasons of low rainfall. Sorghum which has not headed has not the feeding value of the fully matured plants. The crop is much more likely to head in cultivated rows than in drilled or broadcasted seedings.

RATE OF SEEDING SORGHUMS.

PLANTING IN CULTIVATED ROWS.

The rate of planting of sorghums in rows is of more importance from a grain than from a forage standpoint. Most of the sorghum varieties stool, or tiller, freely. When soil moisture is abundant and the stand is thin, each plant produces a large number of tillers, while if moisture is deficient the plant tillers less. This habit tends to equalize in a measure differences in the initial stand.

A large number of carefully conducted tests at agricultural experiment stations in the Great Plains have indicated that a slightly larger forage yield is obtained from fields where the distance between plants

in the row is only 2 to 4 inches than from fields where the spaces between plants are greater. If every seed placed in the soil grew, 1 pound of seed of the Sumac variety or 1½ pounds of Amber sorghum to the acre would be sufficient to provide one plant for every 4 inches in rows 40 inches apart, but it has been found by experience that it is necessary for farmers to sow at least 3 to 4 pounds of seed to insure such a stand. In the drier parts of the sorghum region it is rarely, if ever, desirable to seed more than 4 pounds to the acre, and many prefer less. Farther east, where the rainfall is between 35 and 40 inches, it has been found preferable when growing the crop for fodder or silage to sow as much as 8 to 12 pounds per acre.

The average yield per acre of air-dry Red Amber fodder during a period of five years at Hays, Kans., when the plants were 2 inches apart in the rows, was 3.15 tons; 4 inches, 2.77 tons; 6 inches, 2.79

FIG. 6.—Planting kafir with a 2-row lister at the Fort Hays experiment station.

tons; 8 inches, 2.61 tons; 12 inches, 2.54 tons. At Amarillo, Tex., the average yield per acre of Sumac fodder during a period of four years was for plants 2 inches apart, 4.86 tons; 4 inches, 4.31 tons; 6 inches, 4.21 tons; 8 inches, 4.11 tons. With the grain sorghums no thicker rate than a 4-inch row space was tested. The general results, however, were the same as for the sweet sorghums. At Hays, Kans., the average yield per acre of feterita fodder during a period of four years was, for plants 4 inches apart, 2.59 tons; 8 inches, 2.43 tons; 12 inches, 2.33 tons; 16 inches, 2.17 tons; 24 inches, 1.86 tons. At Amarillo, Tex., the average yield per acre of Blackhull kafir fodder during a period of four years was for plants 4 to 6 inches apart, 3.08 tons; 8 to 10 inches, 2.75 tons; 12 to 16 inches, 2.51 tons. The fodder

yields of Dwarf milo and feterita at Amarillo, Tex., for the same period varied in exactly the same way as the yields of Blackhull kafir. At Chillicothe, Tex., the average yield per acre of Blackhull kafir fodder during a period of 10 years was for plants 4 inches apart, 2.90 tons; 8 inches, 2.66 tons; 12 inches, 2.59 tons; 16 inches, 2.12 tons.

At all the experiment stations the highest fodder yield of both the sweet sorghums and grain sorghums was obtained from the thickest stand. The grain yield, however, was highest from the 8-inch spacing in most cases. Notwithstanding the higher yield of fodder from the

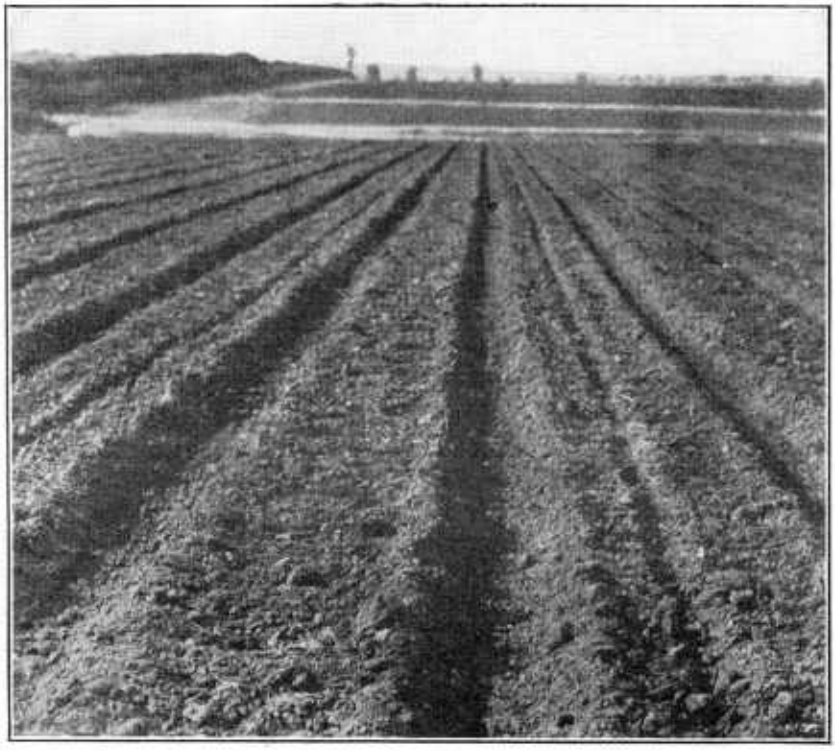

FIG. 7.—A field planted with a corn planter provided with a furrow-opening attachment. (Courtesy of the Kansas Agricultural Experiment Station.)

thick rates, the fodder value was greatest in the intermediate rates. This was due to the more normal maturity of the plants and the greater proportion of grain in the thinner stands. On the basis of these results a 4-inch spacing is recommended for sweet sorghums and an 8-inch spacing for grain sorghums on the Great Plains.

DRILLING OR BROADCASTING.

It has been the general practice among farmers to sow from 45 to 60 pounds of sorgo seed to the acre in drilled or broadcasted seedings. A 5-year test at one field station in Kansas and two in Texas have developed the fact that very little difference in yield is obtained

whether one uses 15 pounds or higher rates up to 75 pounds of seed to the acre (see fig. 3). The 15-pound rate, however, gives a coarser growth, which is more likely to be infested with weeds, especially if the seed-bed conditions are not first class or the weather is not favorable for good germination of the seed and a vigorous early growth of the plants. It is recommended, therefore, on this basis west of the one hundredth meridian in the Great Plains to sow 30 pounds, between the ninety-eighth and one hundredth meridians 45 pounds, and east of the ninety-eighth meridian 60 to 75 pounds of seed to the acre.

CULTIVATION OF SORGHUMS.

The early growth of sorghum is slow, and the young plants therefore require care to prevent their being overcome by weeds. The first cultivation can be accomplished with an ordinary drag harrow, or, if the field is listed, with a disk weeder. Where the field has been plowed late in the spring and then surface planted, one cultivation with a drag harrow soon after the sorghum has emerged, to be followed by later cultivations with an ordinary shovel cultivator, is most efficient. Sorghum when surface planted grows faster than when planted with a lister, so that there is less immediate danger of weeds getting ahead of the crop.

In listed plantings, after the harrow has been utilized for the first cultivation, a cultivator with knives on each side designed to cut under the weeds is especially efficient in killing those on the edge of the furrow. A homemade cultivator of this sort, often called by the western farmer a "go-devil", is made by attaching heavy steel blades 30 to 40 inches long to a narrow sled, the runners of which are 2 by 10 planks at least 5 feet long and only 8 to 10 inches apart. To each side of the sled is bolted one of these blades, so that it extends backward at an angle of about 45°. These blades should be 4 or 5 inches wide and sharpened along the entire front edge. Attached in directly opposite positions, they have a spread of approximately 4 feet 6 inches. When the sled is running in the furrow the knives cut through the ridges on each side a little beyond the center, thus entirely freeing these spaces of weeks. If the knives are set at the proper angle they will maintain a fairly constant depth and free themselves of roots and trash, with the operator riding on the sled. When well made this sled cultivator is very efficient.

Manufactured knife cultivators are on the market, as well as disk cultivators designed especially for listed crops. (Figs. 8 and 9.) Some of these handle two rows at a time and are reasonably efficient, but none of the trade cultivators is more effective in killing weeks than a good homemade sled cultivator. After the sorghum is 10 or 12 inches high a shovel cultivator can be used. Late cultivations should be shallow, in order to avoid breaking the feeding roots.

THE TIME TO HARVEST SORGHUMS.

Sorghum should be fairly mature before being cut for forage. There are several reasons for this: The largest tonnage of dry matter is obtained from mature sorghums, the feed is more palatable, the danger from prussic-acid poisoning is less, the fodder does not sour in the shock so easily, there is a smaller shrinkage in weight during the curing, and the silage made from mature sorghum contains less acid and does not spoil when properly ensiled.

The best time to cut sorghum for fodder is when the seeds have reached the hard-dough stage. Cut at this time, the sap in the stem is sufficient to complete the development of the seed after the fodder is shocked. Drilled or broadcasted sorghum should also be allowed

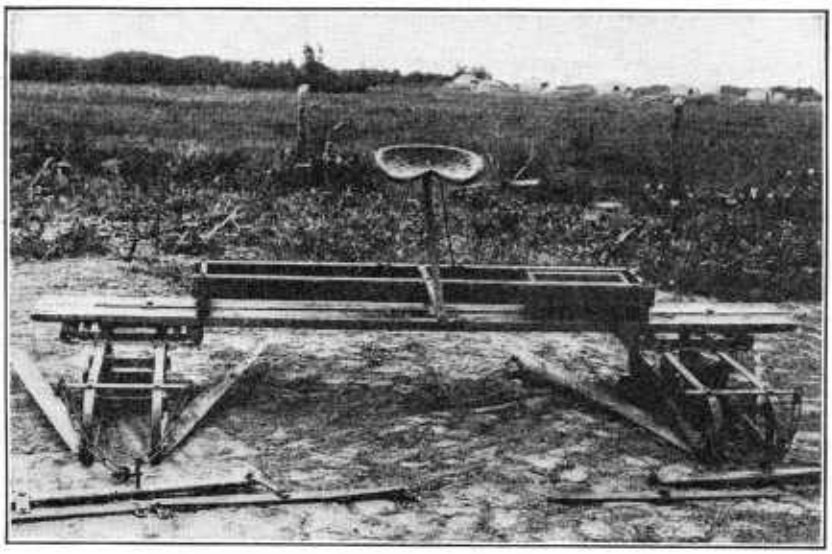

FIG. 8.—A knife cultivator now on the market which is constructed on the same principle as the home-made sled cultivator except that it cleans two rows at one trip.

to form seed before it is harvested, unless dry weather interferes with its full development and threatens to ruin the crop. Experiments in which cuttings were made at different stages of maturity show not only that the largest quantity of cured forage is obtained when the crop is harvested after the seeds are well formed, but also the highest acre yield of protein, carbohydrates, and fat.

METHODS OF HARVESTING THE SORGHUMS FOR FODDER, SILAGE, AND HAY.

When labor was cheap the almost universal method of harvesting sorghum grown in rows was to cut the standing plants near the ground with corn knives and place them in shocks to cure. If the grain only was desired, the heads were cut and thrown directly into a wagon box. This method is widely used to-day by farmers who grow only

a small acreage of sorghum or who are not supplied with labor-saving farm machinery.

The increasing cost of farm labor has made it necessary to substitute machines for laborers wherever practicable. The most efficient machine for harvesting sorghum as fodder is a row binder (fig. 10), with which a farmer assisted by one man to set up the bundles in shocks can take care of a considerable acreage of sorghum. When once carefully shocked, sorghum keeps in good condition until late in the winter and can be hauled to the barnyard to be fed or stacked whenever other work is not pressing. (See the illustration on the title-page.)

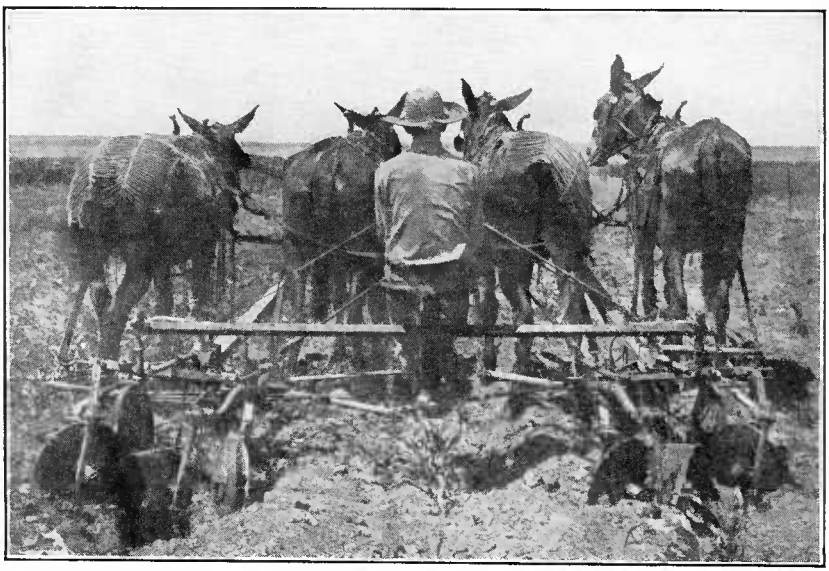

FIG. 9.—A combined disk and shovel 2-row cultivator that is much used in the West for cultivating listed sorghum and corn.

When the crop is intended for silage a row binder should be used. The bundles tied securely are much easier to haul to the silo than loose stalks cut with a corn knife.

Broadcasted or drilled sorgo is usually harvested as a hay crop with a mower and rake. In dry climates farmers often harvest "sowed cane" with a binder, but unless very dry weather prevails it may spoil in the bundle. Care must be observed in curing the sorgo when it has been cut with a mower, as the stems are very juicy, and it takes a long time to cure sufficiently to be ready for the stack. It is best to allow the crop to lie in the swath for a day or two, then rake into windrows and leave at least four days, or longer if the weather is not favorable for curing. As soon as the leaves are fairly dry the hay may be placed in cocks to complete the curing process.

THE PRODUCTION AND VALUE OF GOOD SORGHUM SEED.

For his own seeding the farmer should use heads selected in the field before frost. This seed, even though slightly immature, will germinate well if the heads are thoroughly cured by hanging them upon wires in the barn loft or granary. The practice of curing ears of seed corn in this way is common among corn growers and has resulted in a decided improvement in the crop. All sorghums cross-pollinate freely in the field. The sweet sorghums are more often mixed as to variety than the grain sorghums, because the seed crop is secondary in importance to the fodder. A special effort is therefore necessary to produce pure seed. Where a field is intended for seed production it should be rogued carefully; otherwise the presence of

FIG. 10.—Cutting sorgo with a row binder. This shows the best way of harvesting row sorghums for fodder and silage

stray plants of other varieties will result in endless hybridization. This intermixing of varieties results in a lack of uniformity in ripening as well as in the size of the plants, thus causing difficulty in harvesting and loss in marketing the crop.

Sweet-sorghum, or "cane," seed is harvested in the same way as the seed of grain sorghums. The most economical method is to use a grain header, but much of it is still gathered by hand from standing stalks in the field or after the crop has been cut with a row binder and shocked. (Fig. 11.) Considerable extra money may be realized by farmers in the sorghum belt if they will save the seed from their sorghum fodder. This is particularly true when standard sorgo varieties, such as Black Amber, Sumac, Orange, Honey, and Gooseneck are grown.

Large quantities of the harvested heads thrown together in a crib or bin are likely to heat and lose their germinating power. In dry climates they may be piled in narrow ricks in the open, but it is better to place these ricks under cover. Seed intended for feeding purposes is not injured much by a little moisture, but wet seed and immature seed are rendered almost worthless for planting if freezing temperatures occur.

Neighbors may work together very effectively in thrashing sorghum seed, the heads being hauled to some designated central point. An ordinary grain separator can be used effectively for thrashing if properly adjusted. To avoid cracking the seed it is best to remove all but two or three rows of concave teeth and reduce the speed of the cylinder to about two-thirds that used in thrashing wheat. The distance between the cylinder and the concaves should be increased when thrashing soft-grained sorghums, like feterita, and lessened for the sweet sorghums, which are harder to thrash.

THE VALUE OF SORGHUM-LEGUME MIXTURES.

The practice of seeding mixtures of sorghum and cowpeas or of sorghum and some other legume, such as soy beans or velvet beans, when forage alone is desired, is commendable in theory, but in actual practice it has not been a complete success. On the Great Plains, where the rainfall is deficient, the sorghums make a more vigorous growth than cowpeas or soy beans and usually crowd out the legumes. In the humid regions such mixtures are more successfully grown, but the difficulty of harvesting the mixed crop prevents its extensive use. The growing of any mixture of this kind should be attempted only in localities where both the sorghum and legume are well adapted to climatic and soil conditions.

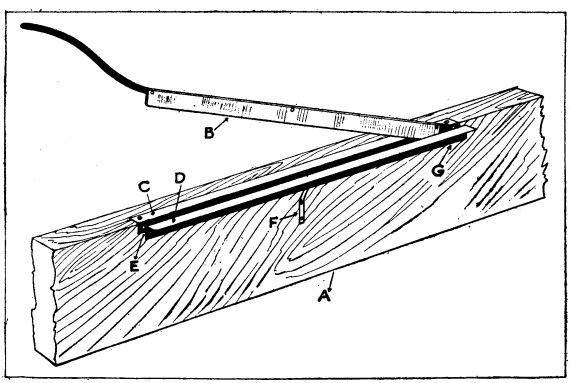

FIG. 11.—A contrivance for cutting the heads from bundles of sorghum: *A*, Plank 2 by 8 inches by 10 feet long which can be bolted to the side of a header box or wagon box; *B*, a stout knife 24 to 28 inches long hinged on the bolt *G*, *C* and *D*, angle irons fastened to the top of the plank half an inch apart. *C* is fastened with lag screws and *D* with bolts *E* and *G*, passing through the plank and with brace *F*.

THE UTILIZATION OF FORAGE SORGHUMS.

USE AS A HAY CROP.

In the United States south of latitude 37° and east of longitude 105° sorghum hay is quite widely used on the farms to feed work mules and, to a lesser extent, other farm animals. Though some-

what laxative, it is nutritious, and work animals maintain their vigor when fed on it even though their grain ration is light.

When grown for hay, sorghum is usually broadcasted or drilled. In the region just mentioned it is often sown as a catch crop, occupying land which otherwise would lie idle. A small part of the hay is marketed loose near by, but sorghum is not especially desirable as a market hay, because it is rather coarse and difficult to cure sufficiently well to stand baling. Sorghum is extremely valuable in the Southern States, however, on account of the certainty of producing a crop. No other hay grasses have been found equal to it in this respect except Johnson grass and Sudan grass. Both of these make smaller yields, and Johnson grass becomes a weed on fertile soils.

USE AS FODDER.

A large percentage of the sorghum used for forage purposes is cut and fed as fodder; that is, the whole plant with the head or grain attached is cured and fed without removing the grain. Nearly all the sweet sorghum grown in cultivated rows and about 40 per cent of the grain-sorghum acreage are handled in this way. The sweet sorghums produce on the average about 1 ton per acre more fodder than the grain sorghums, and live stock of all kinds eat the stems more readily on account of their sweetness.

A long period for curing in the shock is necessary to the production of good sorghum fodder. In regions where the rainfall is light little injury is sustained by the fodder in standing out through the winter, and most of it is fed from the shock instead of being stacked. Some difficulty is experienced in certain sections with sorghum souring in the shock. This trouble usually arises from cutting the sorghum while it is immature.

Well-cured fully matured sorghum fodder will maintain live stock in good condition through the winter with little or no supplementary grain ration. Chemical analyses indicate that the food value of sorghum fodder is practically the same as that of corn fodder, and it is much more palatable; hence can be fed with less waste. The high value of kafir fodder in wintering cattle and work animals has been fully demonstrated by feeding tests at the Fort Hays experiment station, Hays, Kans.

The feeding of shredded sorghum fodder, mixed with corn chop, bran, cottonseed meal, or other concentrates, has given good results with dairy cows, and during the heavy feeding periods with beef cattle. Shredding the fodder before feeding decreases the waste, but unless the feeding operations are conducted on a large scale and the equipment includes a powerful engine, the practice of shredding fodder is not often profitable.

USE AS A SOILING CROP.

Sorghum can be used as a soiling crop provided care is observed to avoid bloating and prussic-acid poisoning. The crop becomes available during the period of summer drought when pasture and other feeds are scarce. It can be cut from the time it is 2 to 3 feet high until it ripens, but the early cuttings have inferior feeding value and are more likely to contain dangerous quantities of prussic acid. Unless feed is badly needed, therefore, it is best to delay cutting until the plants have headed.

Successive seedings must be made or several varieties of different degrees of earliness used, in order to extend the soiling season over a considerable period. A second growth starts promptly from the

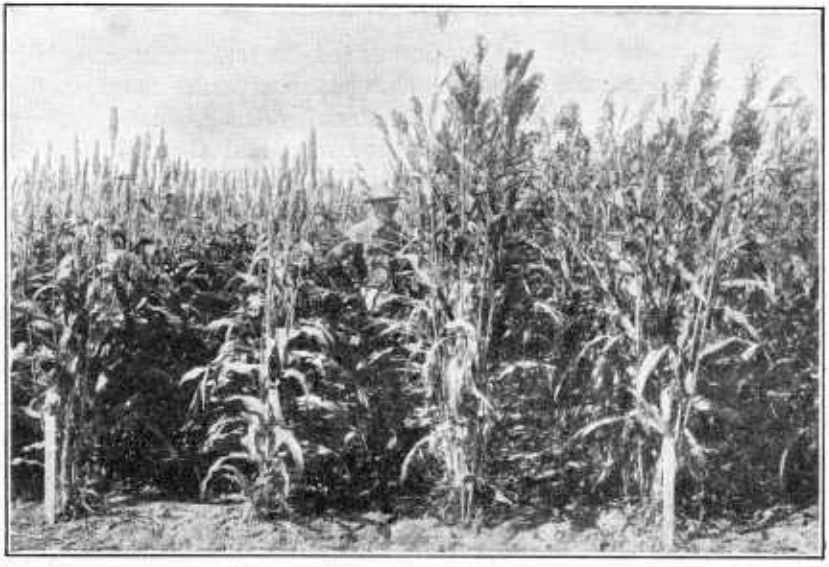

FIG. 12.—Red Amber sorgo and Blackhull kafir grown for silage at the Fort Hays experiment station, Hays, Kans. Blackhull kafir on the left, Red Amber sorgo on the right. Planted June 1; photographed September 6. Yields per acre: Blackhull kafir, 15.73 tons; Red Amber sorgo, 17.33 tons.

stubble, especially when the plants have been cut before maturity. The yield of soilage from sorghums is larger than from almost any other crop. Yields of 12 to 15 tons per acre may be expected on fairly fertile soils. (Fig. 12.) The crop can be grown for soiling purposes either in cultivated rows or in close drills. Harvesting is a comparatively simple matter, the drilled sorghum being handled with a mower and rake and that in rows with a row binder or corn knife.

USE AS SILAGE.

Until recent years sorghum was not valued highly as a silage crop. This was largely because farmers did not understand the necessity of allowing the crop to ripen before it was cut. Silage made from immature sorghum is sour and does not keep well. When sorghum

is not cut until the seeds are hard the silage has less acid than corn silage and keeps fully as well. (Fig. 13.)

The average acidity for the different kinds of silage, as determined by the Kansas Agricultural Experiment Station in 1913, was as follows: Corn, 2.03 per cent; sorgo, 1.46 per cent; kafir, 1.43 per cent.[8]

By a series of experiments which fully demonstrate the value of sorghum silage the Kansas Agricultural Experiment Stateon has done much to over come the early prejudices. Silage made from kafir was found equal to corn silage whether fed to beef cattle or to dairy cows. Sweet-sorghum silage was 3 per cent less valuable

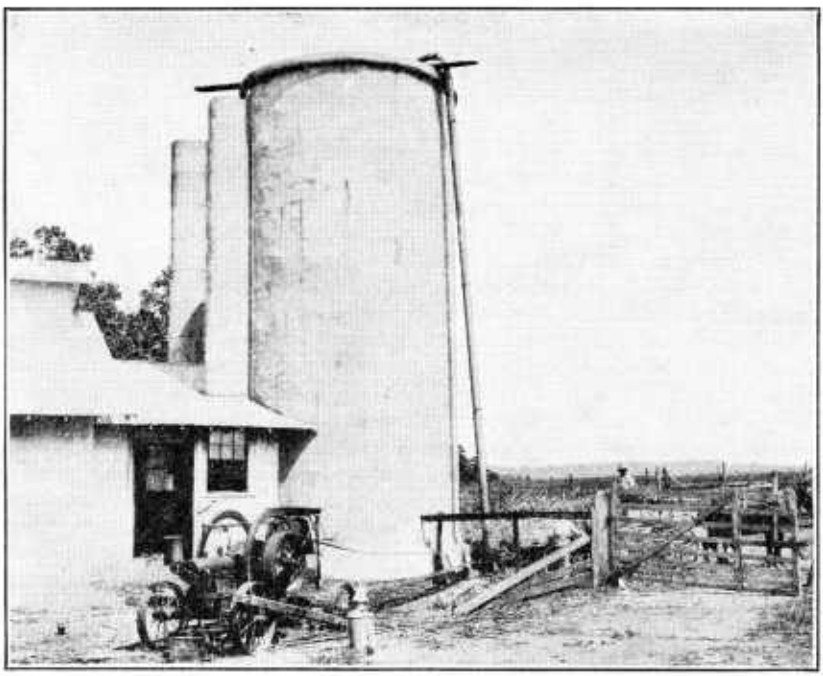

FIG. 13.—Filling a silo with sorghum near Athens, Ga. The value of this crop for silage is growing in appreciation each year.

than corn silage, pound for pound, when measured by the milk produced,[9] but when fed to beef cattle it was fully equal to corn silage.

Corn, kafir, and sorgo silages were compared in feeding experiments with beef calves conducted by Prof. W. A. Cochel at the Kansas station during a period of three winters. A ration consisting of corn silage, wheat straw, and cottonseed meal produced an average daily gain of 1.19 pounds at a cost of 5.26 cents per pound of gain. Kafir silage substituted for the corn silage resulted in a daily gain of 1.28 pounds at a cost of 4.88 cents per pound, and sorgo silage substituted for corn silage resulted in a daily gain of 1.12 pounds at

[8] Reed, O. E., and Fitch, J. B. Sorghum crops for silage. Kans. Agr. Exp. Sta. Circ. 28, 6 p. 1913.
[9] Reid, O. E., and Fitch, J. B. Op. cit.

a cost of 5 cents per pound. The average daily ration was 27 pounds of silage, 1 pound of cottonseed meal, and, in addition, all the wheat straw the animal would eat.

The striking advantage of sorghum silage over fodder in a ration for wintering live stock was shown at the Fort Hays Branch Experiment Station in 1912–13. A ration of 27 pounds of kafir fodder, 10 pounds of wheat straw, and 1 pound of cottonseed meal fed to breeding cows resulted in a daily gain of only 0.5 pound and cost 19.82 cents per pound of gain. A daily ration of 35 pounds of kafir silage, 14 pounds of wheat straw, and 1 pound of cottonseed meal resulted in a daily gain of 1.34 pounds at a cost of 4.7 cents per pound. Experiments at the sae station in the winter of 1918–19 indicated that 1 acre of kafir fed to cows as silage was equal to 1.78 acres fed as fodder.

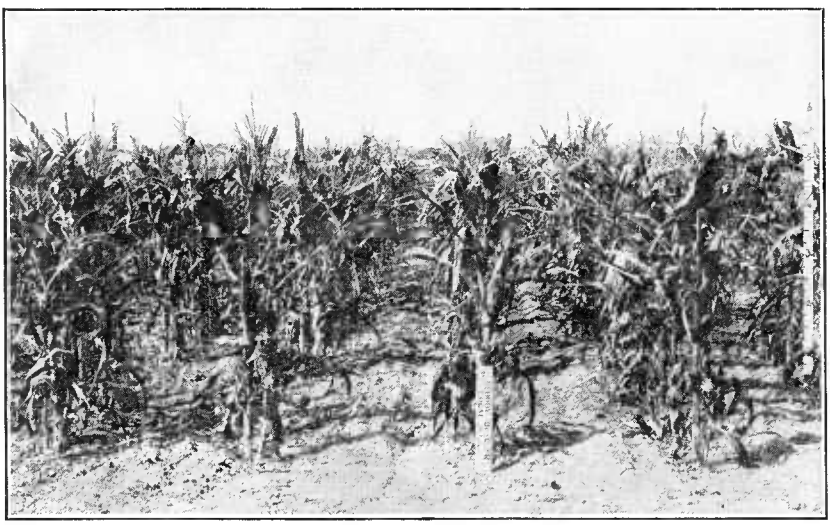

FIG. 14.—Bloody Butcher corn at Hays, Kans., August 27, 1919, showing the behavior of corn on the uplands of western Kansas in average years.

The silage yield of sorgo, especially in the Great Plains area, is consistently larger than that of Kafir or corn. (Figs. 12 and 14.) The results obtained, therefore, when figured on the basis of pounds of beef or gallons of milk per acre, are very favorable to sorgo. This is illustrated graphically in figure 15, which compares sorgo, corn, and kafir when grown on fertile soil in the eastern part of the State.

The diagram (fig. 15), giving as it does the potential acre value of sorgo in gallons of milk and pounds of beef per acre, shows in a striking manner the high value of this crop when it is utilized as silage. There is little doubt that some, though not all, of this superiority over corn is lost in the succeeding crop, since most investigators admit that corn leaves the field in better condition for wheat or other small grains than does sorghum.

The higher yielding power of sorghum for silage is shown in nearly all tests reported. At the Kentueky Agrieultural Experiment Station the average yield per aere of eorn silage for a 5-year period from 1915 to 1919, inelusive, was 10.7 tons, as against a yield of 17 tons for sorghum silage. At the Tennessee Agrieultural Experiment Station eorn averaged 7.4 tons, sorghum 14.2 tons, and eorn and sorghum mixed 10.4 tons per aere. At the Miehigan Agrieultural Experiemtn Station eorn made 14.8 tons and sorghum 19.3 tons of silage per aere.

A feeding experiment was carried out at the Kentueky Agrieultural Experiment Station in 1918–19, comparing eorn silage with sorghum silage. The steers fed eorn silage made a daily gain of 2.15 pounds per head. Those fed sorghum silage averaged 1.95 pounds of gain per head daily, notwithstanding that one steer in the sorghum lot was off feed for nine days. A net profit of approximately $20 per steer was realized in both lots with the silage valued at $8 per ton, whieh value gave a gross return of $78.32 per aere for the eornfield and $136 per aere for the sorghum field.

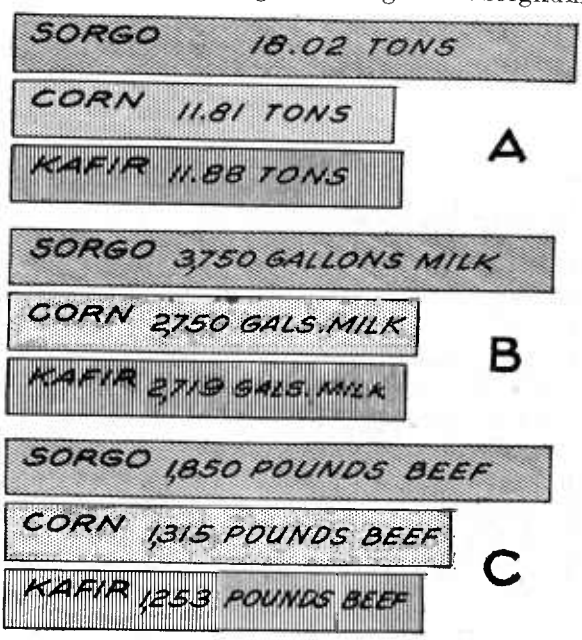

FIG. 15.—Comparison of sorgo, corn, and kafir for silage on rich soil at Manhattan, Kans.: *A*, Average yield per acre for the 5-year period from 1912 to 1916, inclusive (Cunningham, C. C., and Kenney, Ralph. Kans. Exp. Sta. Bul. 218, p. 11, 1917). *B*, Yield of milk obtained from 1 acre of silage when fed to dairy cows in a ration with a small quantity of alfalfa hay and grain (correspondence with J. B. Fitch, August 22, 1919). *C*, Beef obtained from 1 acre of silage when fed to calves in a ration with 1 pound of cottonseed meal.

Stoekmen on the Plains lose large numbers of cattle in hard winters through starvation and freezing. This loss eould be almost entirely prevented by the use of reserve feed stored in pit silos, like those shown in figure 16. These silos are inexpensive to eonstruet and in no danger of destruetion by the wind. In favorable seasons sueh silos ean be easily filled with sorghum, thus holding a surplus of eheap feed in reserve against the time of need. Properly made, silage keeps almost indefinitely in a pit silo. Silage-fed eattle that have aeeess to straw piles eome through the winter in good eondition instead of losing most or all of the gains made during the summer grazing period.

Farmers who keep a few milk cows also find a supply of silage very profitable. Care should be used in planning the diameter of the silo, so that at least 2 inches of the silage will be fed each day after the silo is opened. If the silo is so large that less than this quantity is required for the stock, the ensilage will spoil on top.

USE AS PASTURE.

Sorghum has been recommended as a summer pasture for live stock of all kinds, but there is more or less conflict of opinion regarding its value for this purpose. The general result of well-planned experiments is to discourage its use as pasture both for hogs and cattle. Most of the successes with sorghum as pasture have resulted from the turning in of milk cows on a nearly mature crop.

The danger of prussic-acid poisoning has tended to prevent farmers from pasturing sorghums very extensively, except with hogs. There

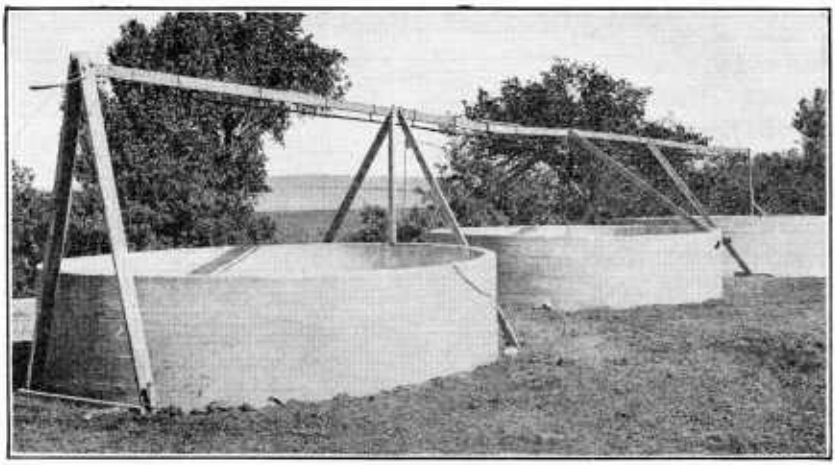

FIG. 16.—Battery of pit silos on a ranch between Hays and Plainville, Kans. These silos are 20 feet in diameter and 25 feet deep.

seems little danger to hogs from the poison, but cattle are particularly susceptible; therefore the sorghum should invariably be tested for poison by turning some animal of little value into the field first. If the poison is present in dangerous proportion the fact will become apparent in a few minutes.

SORGHUM SEED AS A GRAIN RATION.

The utilization of the seed of grain sorghums as a grain ration for farm animals is increasing rapidly. These grains are especially valuable for use in chicken feeds, but can also be fed with good results to cattle, horses, sheep, and hogs. The general belief among feeders is that the sorghum grains are worth about 90 per cent as much as corn when measured by gains in flesh. This is true, however, only of kafir, milo, feterita, and other grain sorghums. Sorgo seed is less valuable because the seeds of nearly all sweet-sorghum varieties contain an

appreciable amount of a bitter principle resembling tannin. This bitter principle has an astringent effect on the digestive processes, evidently thereby lowering the feeding value of the grain.

The relative value of sorgo seed as compared with corn and seed of the grain sorghums is brought out in Bulletin 192 of the Kansas Agricultural Experiment Station.[10] In a feeding test with hogs covering a period of 80 days, a lot fed ground sorgo seed and alfalfa hay made an average daily gain of only 0.88 pound. Those given ground milo in place of the sorgo seed averaged 1.2 pounds per day; those fed ground kafir, 1.3 pounds per day; and those given ground corn, 1.5 pounds per day. Where the ration was only 62 percent corn or sorghum seed, 30 percent shorts, and 8 per cent tankage, the gains were more nearly equal from the different grains.

In another feeding test with hogs at the same station in 1921–22 whole sorgo seed was found to be 67 per cent and ground sorgo seed 77 per cent as efficient as yellow corn in producing gains. When fed to calves the gain produced by sorgo seed cost 2 cents a pound more than the gain from corn.

Additional information on the value of grain-sorghum seed as a substitute for corn in feeding live stock is to be found in Farmers' Bulletin 724 of the United States Department of Agriculture, entitled, "The Feeding of Grain Sorghums to Live Stock."

CHEMICAL COMPOSITION AND DIGESTIBILITY OF SORGHUM FORAGE.

In composition and digestibility, sorghum fodder and sorghum silage are very similar to corn fodder and corn silage. This fact is indicated in Table II, compiled from Henry and Morrison's Feeds and Feeding, sixteenth edition.

TABLE 11.—*Average composition of corn, kafir, and sorgo forage.*

Crop	Number of analyses.	Constituents (per cent)					
		Water.	Ash.	Crude protein.	Fiber.	Nitrogen-free extract.	Fat.
Field-cured fodder:							
Corn	23	39.3	3.6	4.8	16.7	34.2	1.4
Kafir	20	40.0	6.2	5.9	17.7	28.4	1.8
Sorgo	11	37.4	3.1	3.9	17.8	35.0	2.8
Silage from fairly mature plants:							
Corn	121	73.7	1.7	2.1	6.3	15.4	.8
Kafir	3	69.2	2.5	1.8	9.9	15.5	1.1
Sorgo	30	77.2	1.6	1.5	6.9	11.9	.9

According to the above authority, corn, both as fodder and as silage, is slightly more digestible than kafir or sorgo. In fodder, the percentage of digestibility for the dry matter of corn is 66, kafir 59, and sorgo 58. In silage the percentage of digestibility for the dry matter of corn is 66, kafir 55, and sorgo 57.

[10] Wheeler, G. C. Hog feeding. Kans. Agr. Exp. Sta. Bul. 192, p. 353–426, 8 fig. 1913.

PRUSSIC-ACID POISONING.

A serious disadvantage in the use of sorghum as a pasture or soiling crop is the danger of prussic-acid poisoning. Almost every farmer who has grown sorghum as a farm crop knows that it is dangerous to allow cattle to eat even a small quantity of green sorghum before it has matured. The wild animals of Africa are said to avoid sorghum instinctively while it is young, refusing to eat it until it has ripened. However this may be, domestic animals in America show no such intuition, and a considerable loss of cattle is sustained each year in the United States from sorghum poisoning.

The following points have been fairly well established:

(1) Sorghum is most dangerous when its normal growth has been interrupted by an acute drought or by frost.

(2) The prussic-acid content of sorghum decreases as the plant approaches maturity. Mature plants with ripe seeds are seldom dangerous, especially if the growth has been normal.

(3) The slow curing of sorghum releases three-fourths of the prussic acid and ordinarily makes the cured fodder safe to feed animals. Rapid drying releases less of the acid and is therefore a less effective safeguard.[11]

(4) Sorghum silage can be fed with safety.

(5) Loss usually comes from pasturing cattle on sorghum. This should never be attempted without first testing the field with an animal of little value. Even if the sorghum appears safe to pasture after such a test, the herd should not be turned in the field with empty stomachs. A light feed of grain given prior to turning the animals on the sorghum will do much to prevent injury.

(6) Less trouble is experienced in the Southern States than in those farther north.

The following remedy for cyanide poisoning, when it can be administered immediately after symptoms of poisoning appear, has been recommended by the Bureau of Animal Industry.[12]

The injection of methylene blue, sodium nitrite, or sodium thiosulphate, preferably intravenously, has proved to be a practicable and valuable procedure. Especially promising is the injection of a combination of sodium nitrite and sodium thiosulphate. For cattle, 2 to 3 grams of sodium nitrite in water, followed by 4 to 6 grams of sodium thiosulphate in water, has protected against two minimal lethal doses. For sheep, up to 1 gram of sodium nitrite and 2 to 3 grams of sodium thiosulphate are recommended. This treatment may be supplemented by other measures such as injections of atropine, the inhalation of ammonia, injections of glucose, or symptomatic treatment. Since the use of these drugs is attended with some danger to an animal, a trained veterinarian should conduct or supervise the treatment.

DISEASES OF SORGHUMS.

RED-SPOT.

The red-spot, formerly known as "sorghum blight," is perhaps the most troublesome of all sorghum diseases from a forage standpoint. It affects both the stem and leaves of the plant, manifesting itself

[11] Dowell, C. T. Cyanogenesis in Andropogon sorghum. *In* Jour. Agr. Research, v. 16, no. 7, p. 179. 1919.

[12] Couch, James F. Poisoning of livestock by plants that produce hydrocyanic acid. U. S. Dept. Agr. Leaflet 88, 4 p. 1934.

in red or purple spots, which at first are more or less circular, but which spread most rapidly lengthwise of the stem or leaf, becoming oblong or rectangular splotches (fig. 17). When these discolored areas become very numerous the leaves cease to function and the growth of the plant stops. Three species of bacteria cause the spotting.

Red-spot is most destructive in warm, humid climates like that of the Gulf coast. It is always to be found on the Great Plains, but does little damage except in wet seasons. Some varieties are more susceptible to it than others. Sudan grass is of little value in Florida and

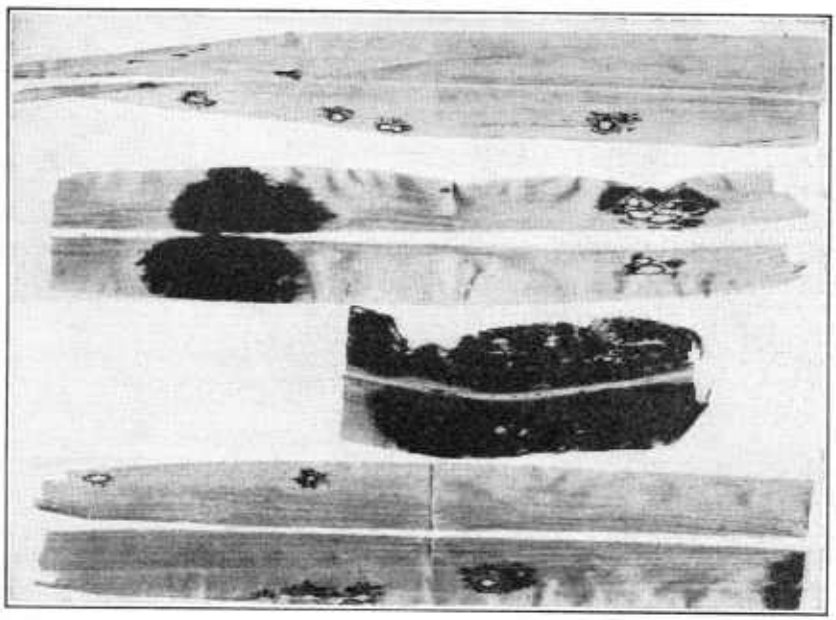

FIG. 17.—Leaves of one of the sweet sorghums affected by red-spot, or sorghum blight. Note the characteristic small red spots on the two outer leaves. The larger areas on the center leaves show how these spots spread over the leaf in the later stages.

other parts of the Gulf coast because of its suceptibility to this disease.

No remedy or preventive of the red-spot has yet been found other than the growing of resistant varieties. In localities where it is especially destructive, as along the Gulf coast, Japanese cane or Napier grass should be grown instead of the sorghums.

KERNEL SMUT.

The kernel smut of sorhums is most important, of course, from the standpoint of grain production. All the principal groups of sorghums except milo and feterita are subject to kernel smut, and the losses in some districts are quite severe.

In the kernel smut the individual grains or kernels in the head are attacked and changed into a mass of dark-colored spores. The head

itself retains its shape and these spore masses look somewhat like elongated seeds. Unlike the red-spot, kernel smut can be controlled by seed treatment. The formaldehyde treatment is probably the most effective. One pound of 37 per cent formaldehyde solution is mixed with 30 gallons of water. The sacks of seed are immersed for one hour in this solution, which should be stirred occasionally. Then the sacks are taken out and drained, after which the seed is spread upon a clean floor or canvas to dry. When dry the seed may be sown, but care must be taken to see that it does not come in contact with any infected sacks after the treatment.

HEAD SMUT.

The disease known as head smut is much less common that the kernel smut. The whole head when it emerges from the upper leaf is a mass of dark-colored spores mingled with the fibrous remnants of the host tissue and inclosed within a grayish membrane. This membrane soon ruptures and permits the escape of the spores.

Head smut can not be controlled by seed treatment, largely because soil infestation is known to occur. The only safe plan is to avoid the use of seed from localities where it is known to occur and to cut out and burn all plants affected with it before the spores ripen.

INSECT ENEMIES.[14]

GRASSHOPPERS.

Grasshoppers are troublesome principally in the semiarid regions and cause the greatest damage in Kansas. They prefer alfalfa and corn to sorghum, but when they become very numerous or the alfalfa is harvested and a field of corn is not readily available, they become quite injurious to the sorghums. They can be controlled most effectively by scattering poisoned bran mash about the edges of the field. This poisoned mash is made up as follows:

Bran	pounds	25
Paris green or white arsenic	do	1
Molasses	quarts	2
Oranges or lemons (finely chopped)		6
Water	gallons	3 to 4

The bran and Paris green are thoroughly mixed dry in some receptacle, such as a wash tub. The juice of the oranges or lemons is squeezed into the water, the pulp and peeling chopped fine and added, after which the molasses is dissolved in the water and the poisoned bran is moistened with this solution. Ordinary table sirup is not as effective as a strong-smelling molasses.

[14] Prepared with the advice and cooperation of W. R. Walton, Entomologist in Charge of Cereal and Forage Insect Investigations, Bureau of Entomology, United States Department of Agriculture.

Where the grasshoppers are troublesome it is best to scatter this damp mash about the field early in the morning, about the time they are beginning to move about. The quantity described in the foregoing formula should be sufficient for 4 to 5 acres.

CHINCH BUG.

None of the better varieties of forage sorghums are liable to be injured very extensively by chinch bugs unless the infestation occurs when the plants are small. So long as favorable growing conditions prevail, the damage will be slight in all cases except in milo, which is much more susceptible to injury than any other well-known variety.

A field of sorghum can be protected from chinch-bug invasion by means of a deep furrow plowed around the edges of the field, running the land side of the plow toward the field. In dry weather the sides of the furrow thus made can be rendered so steep and the earth so evenly pulverized that the chinch bugs can not crawl out of it. In showery weather the bottom of the furrow can be smoothed with a shovel, thus making it easier for the bugs to follow along the bottom than to climb the sides of the ditch. If holes with perpendicular sides are then dug across the bottom of the ditch at intervals of 30 to 40 feet, the chinch bugs will fall into them, and can be disposed of easily by the application of kerosene oil. The bugs commonly pass the winter at the base of bunches of grass and in the piles of trash usually found along fences and hedgerows. Burning this grass and trash in November or December destroys a large percentage of the chinch bugs and does much to prevent trouble with them the following summer.[15]

ANTS.

Ants do considerable damage to newly planted fields of sorghum by eating out the kernel and thus preventing germination. The ants that do this are small and reddish in color. The only practicable way to control them is to prepare the seed bed carefully and plant when the ground is in good condition, so that the seed will germinate promptly. Frequent cultivations help materially in breaking up the ant colonies and thus reducing general injury to the crop.

SORGHUM MIDGE.

The sorghum midge is abundant in the Southern States from central Texas east. In that region it usually prevents the production of sorghum seed to such an extent that the growing of grain sorghum is unprofitable. A description of the sorghum midge and suggestions for controlling it have been published in Farmers' Bulletin 1566.[16]

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[15] Farmers' Bulletin 1780, How to Fight the Chinch Bug.

[16] Gable, C. H., Baker, W. A., and Woodruff, L. C. The Sorghum Midge, with Suggestions for Control. U. S. Dept. Agr., Farmers' Bul. 1566, 9 p., 11 fig. 1928.

The sorghum midge is a very small fly with a red body which lays its eggs within the hulls or glumes of the sorghum flower before blossoming time. The egg produces a small white larva, or grub, which takes its position alongside the developing ovary and absorbs the juices, thus preventing the development of the seed. This larva soon attains its growth and changes into a pupa, from which the adult fly, or midge, emerges in a few days and starts a new generation by depositing eggs on other sorghum heads. Under favorable conditions of temperature and moisture this whole process requires only 14 days, the average time being 14 to 20 days. The adults do not feed on the developing seed; only the larva does injury in this way.

The midge appears first in the spring on Johnson grass and breeds there sufficiently to infest cultivated sorghums in considerable numbers as soon as the crops come into head. All sorghums are subject to its attacks, and it has been found also on foxtail and certain other wild grasses. Absence of the cultivated sorghums from any community throughout an entire year is therefore not disastrous to the midge. It lives over winter in the larval state in heads of the sorghums and Johnson grass which remain as trash on the fields or along the fence rows. Parasites become numerous usually late in the season and destroy large numbers of the midge, but too late to prevent the greater part of their injury to the sorghums.

One way of combating the sorghum midge is by seeding very early in the season, so that the sorghums will come into bloom at a time when the midge is not plentiful. Early seeding and careful harvesting of sorghum fields, together with the destruction of all the Johnson grass in adjoining areas, will lessen the evil, but may not completely overcome it. The damage from a forage standpoint is slight, as the sorghum makes good fodder even when it has failed to form seed, but the lack of home-grown seed of the better forage varieties no doubt tends to decrease the acreage of this crop in the midge-infested States.

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